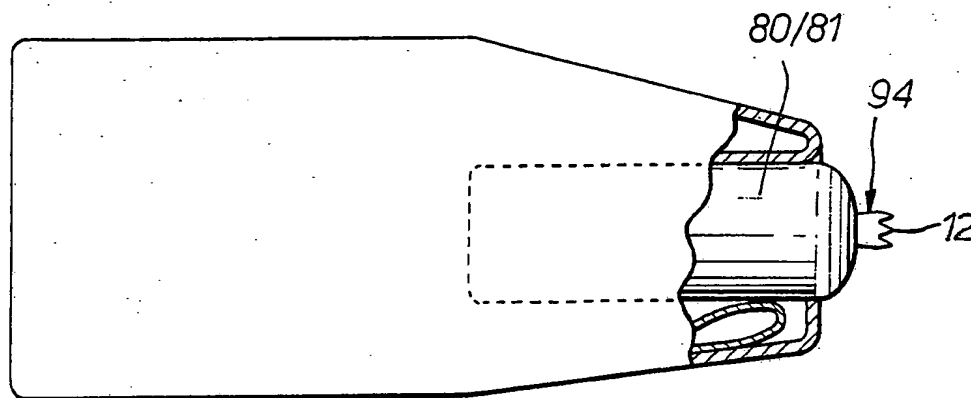




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<b>(54) Title:</b> SPRAYING OF LIQUIDS		

**(57) Abstract**

An electrostatic device for spraying liquids comprises a nozzle (94) in the form of a wick which is contacted with a reservoir containing the liquid to be sprayed, high electrical potential being applied to the liquid in the vicinity of the spraying tip of the nozzle whereby the liquid is drawn out preponderantly under the influence of electrical forces into ligaments which break up to form a spray of electrically charged liquid droplets. The wick is fabricated from sheet (10) of a resiliently deformable polymeric foam material of open celled structure and an edge of the sheet material is profiled to form a plurality of sites (12) at which liquid ligaments can be produced. Typically a toothed profile is employed in which a plurality of teeth (12) form the sites at which ligament formation occurs.

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## SPRAYING OF LIQUIDS

This invention relates to the electrostatic spraying of liquids.

It is known from Applicant's prior EP-A-120633 to effect electrostatic spraying by the application of high potential to liquid supplied to a nozzle which comprises a porous wick-type element formed of the types of porous felt or fibre bundles or plastic pads widely used in graphic implements such as felt or porous plastic tip markers or felt- or fibre-tip pens. In the case of porous pad or fibre bundle nozzle constructions, reference is made to the use of nozzles having a point, bullet head or hemispherical configuration. In the case of felt-tip markers, reference is made to such markers having a chisel-edge configuration.

It is also known from Applicant's prior EP-A-243031 to provide an electrostatic spraying device in which the droplet size can be controlled without the aid of a field adjusting electrode (FAE) by forming a spraying edge of the device with a toothed profile so as to afford a plurality of sites at which the liquid is drawn out preponderantly by electrostatic forces into ligaments which break up into electrically charged particles. The spraying edge is defined by a component over a surface of which the liquid is fed by gravity towards a toothed edge of the component.

The present invention is concerned with an improved form of electrostatic spraying device in which supply of liquid to the spraying edge is rendered substantially independent of gravity without the need for employing a source of pressure in order to effect liquid feed.

According to one aspect of the present invention there is provided an electrostatic spraying device comprising:  
a spraying nozzle in the form of a wick type element;  
a reservoir for containing liquid to be supplied to the nozzle; and  
means for applying high voltage to the liquid at the nozzle to cause the liquid to be drawn into ligamentary form and thereafter break up into electrostatically charged droplets;  
said element being composed of a foam material having an open cell structure through which the liquid is drawn by capillary action.

In contrast with the above mentioned prior art, the spraying nozzle in a device according to said one aspect the present invention

comprises a foam material through which the liquid is drawn by capillary action.

Preferably the foam material is resiliently deformable. The use of a spraying nozzle composed of a resiliently deformable material confers reduced susceptibility to spraying being deleteriously affected as a result of impacts to the nozzle in use. For instance, where as in the prior art a nozzle is composed of a relatively rigid structure such as a bundle of fibres, an impact to the nozzle may result in splitting of the bundle or one or more fibres breaking off from the bundle. Depending on the extent of the damage, the nozzle may cease to function altogether or it may produce a spray in directions which are not desired - for example, towards the body of the sprayer with consequent contamination. In contrast, a nozzle composed of a resiliently deformable material, if impacted, will usually absorb the impact by yielding or deflecting and then resile to its former orientation.

Conveniently the foam material is shaped so as to present at least one feature from which the liquid discharges in the form of a plurality of ligaments.

Advantageously the foam material is in the form of a sheet and is shaped in such a way that each such feature presents a crest extending between opposite faces of the sheet.

Where the foam material is formed from sheet material, each such feature may be formed by cutting the foam material through its thickness.

In one embodiment of the invention, the foam material is in the form of a sheet and is formed with a toothed profile presenting at least one crest extending between opposite faces of the sheet. Usually the included angle at the crest will be no greater than 100°.

In accordance with a preferred feature of the invention the element terminates in at least one tip having a chisel edge configuration, with an edge which is substantially rectilinear or arcuate in a plane normal to the axis of the element. The extremities of the tip may be substantially right angled whereby the liquid tends to be drawn into two well-defined primary ligaments at said extremities.

According to a second aspect of the invention there is provided a ligament mode electrostatic spraying device for spraying liquids in

which the liquid is sprayed from a profiled edge of a strip of sheet material composed of material having open porosity and providing capillary feed of liquid to said profiled edge.

5 Further broad aspects of a device in accordance with the present invention are claimed in Claims 10 and 12 of the appended claims.

Where the wick type element is in the form of a strip of porous or foam material, the strip will usually be of elongated configuration with a width greater than its thickness, the profiled spraying edge being provided at one end of the strip. Thus, the crest or crests  
10 presented by the profiled edge will usually be of a length less than the width of the strip.

In each of the various aspects and features defined hereinabove, said material is preferably composed of hydrophobic material. In this context, by "hydrophobic", we mean that the inherent absorbency of the  
15 material when in a pre-dried condition is such that it will absorb no more than 0.5% by weight of water if exposed to air having 50% RH at a temperature of 23°C and a pressure of 1 atmosphere.

The materials of which fibre and felt-tip markers and pens are widely fabricated, eg cellulosic and nylon materials, tend to be a  
20 hydrophilic nature and we have found that such materials have a propensity to corona when used in relatively humid conditions, and this is thought to be attributable to the absorption of water into the nozzle material rendering it more conductive and hence prone to corona discharge.

25 It is important that the foam or porous material of which the nozzle or wick type element in accordance with any one of the aspects of the invention defined above should be one that provides a substantial capillary rise especially where the level of the liquid in the reservoir falls as the liquid is sprayed from the nozzle. For  
30 effective capillary action, it is desirable that the pore size of the material, eg the cells of the foam in the case of a foam material, are not too large. In addition, for devices intended for the spraying of deodorant and like personal care and hygiene liquid compositions having relatively low viscosity and resistivity (eg. a viscosity of  
35 the order of 10 cP and a resistivity of the order of  $5 \times 10^6$  ohm cm), we find that it is also desirable for the material of which said material is composed to have a dielectric constant of at least 2.8 (measured at  $10^6$  Hz) and to be in the form of a foam, especially when

flow rates in excess of about 1.5 mg/min are required. The reference here to the dielectric constant relates to the material per se rather than the bulk dielectric constant of the foam or porous material and air contained thereby. It will be understood that the dielectric constant can be readily measured by subjecting the material to compression in order to achieve a condition in which all of the voids are substantially eliminated.

Where the nozzle is fabricated from sheet material or a strip of such material, the thickness of the sheet material need not be any greater than 2mm (preferably no greater than 1mm). We have found that relatively thin sheet materials can be employed whilst securing production of multiple liquid ligaments at the or each spraying tip or crest. This arises because the extremities of the tip edge, ie those locations at which the tip edge intersects each of the major faces of the sheet material, afford sites at which ligament formation is favoured resulting in the production of primary ligaments at these sites. In addition, further ligaments may issue at sites intermediate these extremities.

According to a further aspect of the invention there is provided a method of electrostatically spraying a liquid comprising: feeding the liquid from a reservoir thereof to an element of sheet material having open porosity and defining at least one spraying tip or crest of chisel edge configuration whereby the liquid is drawn by capillary action to the tip(s) of the element; and applying high voltage to the liquid at said tip(s) or crest(s) so that the liquid is caused to issue in the form of ligaments at a plurality of sites along the chisel edge of the or each tip, which ligaments thereafter break up to form a spray of liquid droplets.

Also according to the present invention there is provided a method of producing a cartridge for use in an electrostatic spraying device comprising: forming from a sheet of resiliently deformable non-fibrous, non-felted, hydrophobic material having open porosity a wick type element with a profiled spraying edge; and assembling said element to a container for liquid suitable for electrostatic spraying by inserting said element through an opening in the container so that said spraying edge projects from the container and a portion of the element extends into the interior of the

container to provide a capillary feed path for liquid from the container to the profiled spraying edge.

5 The foam material may be one which comprises a sandwich-like structure with first and second substantially impermeable skins enclosing therebetween a mass of interconnected cells. When such a material is used, the spraying edge is formed in such a way that the cells are exposed at the spraying edge. To allow ingress of liquid into the cellular structure, at least part of the skin on at least one side of the structure may be removed.

10 The porous element is conveniently so arranged that the profiled spraying edge is of annular or part-annular configuration, especially where the profiled edge serves to provide a number of tips or teeth from which spraying is effected. Thus, for example, the nozzle may be produced from a sheet of foam material formed at least in the vicinity of the spraying edge into a tubular or part-tubular configuration with one end thereof having said profile.

15 However, for some applications of the invention we do not exclude the case where said wick type element comprises a solid body of porous material, eg a substantially cylindrical body of foam material, with one end thereof formed with said spraying feature or profile. For example, the solid body may have a recess in one end thereof so as to present an annular edge on which a toothed profile is provided. Also we do not exclude the possibility of the spraying edge having a configuration other than annular or part-annular; for instance, it may have a substantially rectilinear configuration.

20 In preferred embodiments of the invention, the or each tip or profile feature from which spraying takes place terminates in the form of a tooth comprising a first pair of flanks converging to a substantially linear edge at the tip of the tooth and a second pair of flanks located in planes generally orthogonal to the first pair so that the tooth tip comprises a substantially linear edge extending between the second flanks. The tooth edge and the second pair of flanks may be intersect at substantially right angles to form two sites (which may but need not necessarily be relatively sharply radiussed) from which ligaments can be drawn under the influence of the electrostatic forces generated in use. Ligaments may also be produced at intermediary sites between the locations of intersection.

In a preferred embodiment of the invention, the device does not incorporate any structure forming a FAE, ie. the nozzle is so arranged that the field strength produced when liquid is present at the tips of the toothed profile is substantially independent of any low potential influence from any low potential influences from the device.

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Conveniently, the device comprises a housing for accomodating the reservoir and the high voltage means which, typically, includes a high voltage generator and a low voltage source, for instance one or more batteries, for powering the generator. In the case where the liquid composition is a personal care product, the device is typically designed so as to be suitable for hand held use. Where the liquid composition is an air freshening fragrance or the like for dispersal in the air, the device may be designed so as to free standing on a flat horizontal surface such as a shelf or table top with the porous element projecting vertically upwards; for instance, the housing may have a flat base or formations for contact with a horizontal surface so that the housing is oriented in such a way that the porous element is disposed with its axis substantially vertical. Alternatively, or additionally, the housing may be intended to be suspended from a generally vertical surface such as a wall in which case it will be provided with a suspension means so arranged that the housing will be appropriately oriented in use. For example, the housing may include a wall contacting surface or formations which, in conjunction with the suspension means, ensures that the porous element is appropriately oriented when the housing is mounted on the wall.

The battery supply may be rechargeable and the device may incorporate circuitry and terminals allowing direct connection to a mains supply for recharging.

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Switch means will normally be provided to enable the high potential applied to the nozzle to be switched on and off. The switch means may be operable by means of a manually displaceable actuator or alternatively may be touch sensitive so that the high potential is applied to the nozzle whenever the device is held in the hand without the need for any conscious action on the part of the user.

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The invention will now be described by way of example only with reference to the accompanying drawings in which:  
Figure 1 is a schematic view of a device in accordance with the invention;



Figure 2 is an enlarged perspective view of the nozzle spraying edge of the device;

Figure 3 is a view showing the configuration of a section of foam sheet material from which the nozzle is formed;

5 Figure 4 is a fragmentary view showing the tip of one of the nozzle teeth as viewed in a direction parallel to the major faces of the sheet from which the nozzle is formed;

Figure 5 is a view similar to that of Figure 4 but showing a modified form of tooth tip; and

10 Figure 6 is a diagrammatic view, partly in section, of a device for spraying air freshening fragrances.

Referring to Figure 1, the device may be generally constructed and arranged to operate in the same manner as the device described in connection with Figures 5 to 9 of EP-A-120633 and reference should be  
15 made to the latter for further details. The liquid composition to be sprayed is contained within a cartridge 80/81 which may enclose a wad or strip of porous material impregnated with the liquid for supply to a nozzle 94 constituted by a porous wick-type element 10 (see Figure 3) which extends into the cartridge to enable liquid to be fed by  
20 capillary action to the tip of the nozzle. Alternatively, where the device is intended to be used in an orientation such that the nozzle produces an upwardly directed spray, as in the case for example of a table or shelf standing room freshening device for spraying fragrance, the liquid may be stored in the cartridge as a body of liquid as such  
25 with the wick element extending into the body of liquid to such an extent that the wick element is supplied with liquid irrespective of whether the cartridge is full or approaching a near empty condition.

The nozzle 94 terminates in a spraying edge 12 having a profile which in the illustrated embodiment comprises a plurality of teeth 14  
30 from which the liquid is projected in use in the form of a plurality of ligaments per tooth, the ligaments being formed and projected preponderantly under the influence of electrostatic forces and thereafter breaking up into charged droplets. As shown in Figures 2 and 3, the spraying edge has 6 teeth but the number may vary according  
35 to requirements. For example, if the flow rate required for a given application is low, then the number of teeth may be somewhat less. Compared with a point or bullet head type nozzle configuration as disclosed in EP-A-120633, it will be understood that the toothed

profile employed in the embodiments of the present invention generates at least two liquid ligaments per tooth and the toothed profile may be adapted according to the number of ligaments (ie. two or more) needed to secure a desired flow rate.

5       The nozzle 32 is fabricated from a strip cut from a sheet of material having open porosity, eg an open celled foam material. The strip has the section shown in Figure 3, which section is formed into a tubular configuration and is inserted as push fit through an opening in the cartridge 80/81 so that the main body of the insert projects  
10       virtually the full length of the container, leaving a small end portion of the strip projecting externally from the cartridge. The externally projecting portion 16 bears the toothed profile and is of outwardly flared configuration which has the effect of increasing the swath width of the spray and also reduces the extent that the local  
15       field strength at each tooth influences the remainder.

At the end opposite to the toothed profile, the strip 10 is tapered so that when the strip is furled about its axis of elongation, the tapered region forms a lead-in to facilitate insertion through the opening in the cartridge. If desired, the strip 10 may be furled into  
20       a tubular configuration and the edges that meet may be secured together. However, this will not usually be necessary since the close fit within the cartridge opening serves to retain the strip 10 in a tubular configuration in the region of the toothed profiling. Once the strip 10 has been inserted into the cartridge, that part which is  
25       within the cartridge interior may tend to unfurl but this does not particularly matter and may be advantageous in exposing a larger surface area of the strip 10 to the liquid.

The foam material typically comprises an elastically deformable sheet material having a sandwich-like structure with a mass of  
30       interconnecting open cells enclosed between a pair of skins so that the cells provide labyrinthine passageways extending throughout the strip 10. To be suitable for the purposes of the present invention, the sheet material should be readily capable of being cut through the thickness thereof to produce sharp edged features. The strip 10 is cut  
35       perpendicularly to the skins so that cells are exposed at the cut edges, which extend perpendicular to the paper in Figure 3. In addition, at least one of the skins may be sanded so as facilitate ingress of liquid into the strip 10 via these faces. It will be

understood that liquid penetrating into the strip 10 will be fed by capillary action to the tips or crests of the teeth 12 where an intense electrical field can be produced by virtue of the relatively sharp tip to effect formation of the liquid at each tip into one or more ligaments which subsequently break up into a spray of droplets. Usually the included angle between the flanks of each tooth will be no greater than  $100^\circ$  and typically somewhat less, eg of the order of  $60^\circ$ . A particularly suitable porous material for use in fabricating the nozzle is porous foamed polyurethane sheet, such as polyesterurethane sheet marketed under the trade names "Permair F", "Permair FS" and "Permair S" by Porvair PLC of Kings Lynn, England which are available in various sheet thicknesses and pore sizes and are used primarily as air filtration media. This material can be readily cut to form the nozzle strip shown in Figure 3. Typically, the thickness of the Permair foam used for the purposes of the present invention is less than 2 mm, eg 0.5 mm; in other words, the strip 10 shown in Figure 3 is typically 0.5 mm thick as considered in a direction perpendicular to the plane of the paper and its central width is typically 4 mm.

Materials other than foamed polyurethanes may be used; clearly the pore size of any material selected should be sufficiently small to ensure adequate capillary rise. In addition, it is desirable that the material should have a dielectric constant of at least 2.8 (measured at  $10^6$  Hz) in order that the material is adequately polar to produce effective capillary action. Further, to avoid undesirable corona discharge, especially in humid conditions, the material when exposed to 50% RH at  $23^\circ\text{C}$  and 1 atmosphere should desirably, when in a pre-dried state, absorb no more than 0.5% by weight of water, assuming exposure to such conditions for a period of time sufficient to achieve an equilibrium state. "Permair F" has been found to be a particularly suitable material meeting these criteria.

The liquid composition contained in the cartridge 80/81 typically contains one or more volatile components, for example a moderately volatile scent oil and an alcohol (highly volatile), the formulation typically having a resistivity in the range of  $1 \times 10^5$  to  $1 \times 10^7$  ohm cm.

The rate of delivery of the liquid composition using a porous wick-type nozzle is ultra-low, eg of the order of  $1 \mu\text{l}/\text{min}$  or less, which is desirable for many forms of personal care and hygiene products. However, if the nozzle terminates in a point or bullet head

configuration, the rate of delivery may tend to be unacceptably slow. The rate of delivery can be increased by providing a nozzle that produces multiple ligaments. In accordance with the present invention, multiple ligaments are formed by configuring the nozzle tip 94 with a toothed profile from the or each tooth of which a plurality of ligaments is drawn in operation of the device. It is possible to secure multiple ligament production from each tooth by imparting a chisel-shape to the teeth such that the tip proper is formed by a sharp edge 12 extending generally perpendicular to the line extending between the tips of adjacent teeth. Thus, as shown in Figure 4, each tooth tip as seen in a plane perpendicular to the major faces of the strip 10 shown in Figure 3, comprises a crest in the form of a linear edge which extends a distance corresponding to the thickness of the material and intersects the major faces at right angles to form two sites 20 from which ligaments are drawn when high potential is applied to the liquid at the nozzle tip.

In the embodiment shown in Figure 4, the main sites for ligament formation are the points of intersection 20; however, some secondary ligament formation may also be observed at random locations along the edge 18 between the points 20. The number of ligaments produced may be increased by radiussing the teeth as shown in Figure 5.

Referring now to Figure 6, the invention is shown embodied in an air freshener device. The device comprises a housing 110, the bottom wall 112 of which is intended in use to be supported on a generally horizontal surface. The housing, 110 is provided with a compartment 114 to which access can be gained by removal of cover 115 so that a cartridge 116 containing the fragrant liquid composition to be sprayed can be inserted into the compartment. The liquid is one which is suitable for electrostatic spraying and is selected to have suitable properties, eg resistivity and viscosity, for this purpose. The cartridge 116 is of squat parallelepiped configuration, its smallest dimension being in the vertical direction such that the vertical distance between its bottom wall 118 and the liquid level when the cartridge is full is about 10 mm. The bottom wall 118 has a recess 120 therein which acts as a sump.

A capillary wick 122 formed from a portion cut or stamped out from a sheet of a polymeric and resiliently deformable foam material, such as "Permair F" foamed polyesterurethane rubber, is located within

the cartridge so as to be generally vertical with its lower end received within the recess 120 to allow liquid supply to its upper end to be maintained as the liquid level approaches the near empty condition. The upper end of the foam wick 122 projects through an opening defined by upstanding collar 124 and through an aperture 125 in the cover 125, locating means 126 being provided to position the wick 122 within the collar 124. The upper end of the wick is suitably profiled in the manner described above in relation to Figures 1 to 5 to produce two or more liquid ligaments, the number required and hence the number of teeth employed being selected according to the spraying rate required.

The cartridge 116 is adapted to provide for the connection of the liquid therein to the high voltage output of a high tension generator 128, the cartridge being formed from an electrically insulating material and having an electrical contact 130 located in the base of the recess 120 so that, when the cartridge is correctly located within the compartment 114, the contact 130 registers with a terminal 132 connected to the high voltage output of the generator 128. The bottom wall 118 of the compartment 114 includes a depression 134 for reception of the recess 120 so that when the cartridge is in place, the bottom wall 118 is generally parallel with the bottom wall 112. The compartment 114 and the depression may be so dimensioned and arranged that the cartridge can only make operative contact with the terminal 132 if inserted correctly in the housing.

The low voltage side of the generator 128 is connected to a low voltage circuit 140 including one or more batteries (typically 9 volts) and can be switched on or off by means of a user operable switch 144. The generator 128 produces a low current, high voltage output which is typically of the order of 5 to 15 kV and in use this voltage is applied to the liquid contents of the cartridge 116 to effect spraying of the liquid from the profiled upper edge of the wick 122. The low voltage circuit may be arranged to control the generator and thereby control spraying according to requirements. A connection from the low voltage circuit to earth is made through the bottom wall 112 of the housing.

The foam wick 122 provides sufficient capillary rise when disposed vertically to feed liquid from the cartridge to the profiled upper edge of the wick irrespective of the liquid level within the

cartridge. By appropriate selection of the polymeric foam material and the dimensions of the wick 122, the rate of spraying from the profiled upper edge of the wick can be maintained substantially uniform as the liquid level progressively reduces from the fully filled condition to the near empty condition. For instance, by selection of the polymeric material in accordance with the criteria previously mentioned in relation to the embodiment of Figures 1 to 4, the spraying rate may be readily maintained within 10% of the rate achievable at the full condition as the liquid level reduces by 10 mm to the near empty condition.

An annular gap 142 is defined between the wick 122 and the collar 124 to allow the ingress of air as the liquid is discharged from the cartridge. The gap 142 is dimensioned so that, if the cartridge is inverted or otherwise oriented in a position in which the liquid could drain from the cartridge via the gap 142, the gap traps and holds the liquid by surface tension forces to prevent leakage. The cartridge is conveniently provided with a sealing cap (not shown) which can be fitted over the exposed upper end of the wick 122 and engages the collar 124, eg with a screw-threaded or snap-fit engagement, to seal the cartridge when not in use. Instead of allowing air ingress via a gap 142 as described above, the foam wick 122 may have a substantially sealed fit within the collar 124 and a separate air ingress port 152 may be provided. This port may be fitted with a plug (not shown) to prevent leakage, the plug being removed by the user, for example after or during insertion of the cartridge into the housing 110.

In use, the liquid is fed solely by the capillary action of the wick to the upper profiled edge of the wick where it is caused to issue as two or more ligaments (depending on the number of teeth presented by the profiled edge) which thereafter break up into electrically charged droplets, the droplets being drawn towards surrounding earthed objects within the vicinity, eg the ceiling and walls within a room to which fragrance is to be imparted. To prevent build up of electrical charge on the cover, the cover is fabricated from a semi-insulating material (typically having a bulk resistivity in the range from  $10^{12}$  to  $10^{14}$  ohm cm. for example a polyacetal such as "Delrin", and certain grades of rigid PVC) and an electrode 160 embedded within the cover 115 is connected to a low potential such as earth by a lead 162 so that any electrical charge accumulating on the

cover is leaked away thereby preventing build up of a spray suppressing potential on the cover. Although the electrode is shown as being associated with the cover, it may be associated with the housing 110 and arranged so as to contact the cover 115 when the latter is in position on the housing thereby providing a leakage path to earth.

Instead of employing an electrode 160 to effect leakage of charge to earth, in an alternative embodiment the cover may be composed of a hydrophobic, highly insulating material (typically  $10^{15}$  ohm cm and upwards, such as polypropylene) so that electrical charge accumulating on the cover as a result of charged droplets falling on to the cover, is substantially immobile thereby limiting the extent to which the cover may charge up and hence avoiding suppression of spraying.

Whilst not limited thereto, the invention is particularly applicable to devices for spraying liquid compositions suitable for use in personal care and hygiene products, such as deodorants, perfumes, anti-perspirants and hair sprays, and for use in spraying fragrances for air freshening.

## CLAIMS

1. An electrostatic spraying device comprising:  
a spraying nozzle in the form of a wick type element;  
a reservoir for containing liquid to be supplied to the nozzle; and  
means for applying high voltage to the liquid at the nozzle to cause  
the liquid to be drawn into ligamentary form and thereafter break up  
into electrostatically charged droplets;  
said element being composed of a foam material having an open cell  
structure through which the liquid is drawn by capillary action.
2. An electrostatic spraying device as claimed in Claim 1 in which  
the foam material is shaped so as to present at least one feature from  
which the liquid discharges in the form of a plurality of ligaments.
3. A device as claimed in Claim 2 in which the material is in the  
form of a sheet and is shaped in such a way that each such feature  
extends between opposite faces of the sheet.
4. A device as claimed in Claim 3 in which the material is in the  
form of a sheet and is formed with a toothed profile presenting at  
least one crest extending between opposite faces of the sheet and  
forming said features.
5. A device as claimed in Claim 3 in which each such feature is  
formed by cutting the foam material through its thickness.
6. A device as claimed in Claim 1 in which the element terminates in  
at least one tip having a chisel edge configuration, with an edge  
which is substantially rectilinear or arcuate in a plane normal to the  
axis of the element.
7. A device as claimed in Claim 6 in which the extremities of the  
tip are substantially right angled whereby the liquid tends to be  
drawn into two well-defined primary ligaments at said extremities.
8. A ligament mode electrostatic spraying device for spraying  
liquids in which the liquid is sprayed from a profiled edge of a strip  
of sheet material composed of material having open porosity and  
providing capillary feed of liquid to said profiled edge.
9. An electrostatic spraying device comprising:  
a spraying nozzle in the form of a wick type element;  
a reservoir for containing liquid to be supplied to the nozzle; and  
means for applying high voltage to the liquid at the nozzle to cause  
the liquid to be drawn into ligamentary form and thereafter break up  
into electrostatically charged droplets;



said element comprising a strip of sheet material having a porous structure through which the liquid is drawn by capillary action and spraying being effected from at least one tip presented by a profiled edge portion of said strip.

5 10. A ligament mode electrostatic spraying device for spraying liquids, comprising:

a container for liquid to be sprayed;

a nozzle having a spraying edge;

means for supplying liquid from the container to the nozzle; and

10 means for applying a high electrical potential to the liquid so that the liquid is projected in use as ligaments from the spraying edge of the nozzle preponderantly under the influence of electrostatic forces; the nozzle comprising an element in the form of a porous, non-fibrous, non-felted sheet material which provides for capillary feed of the  
15 liquid from the container to the spraying edge and said spraying edge being constituted by a profiled edge portion of said sheet material.

11. A device as claimed in any one of Claims 1 to 10 in which said material is resiliently deformable such that the nozzle is resiliently yieldable to impacts.

20 12. An electrostatic spraying device comprising:

a spraying nozzle in the form of a wick type element;

a reservoir for containing liquid to be supplied to the nozzle; and

means for applying high voltage to the liquid at the nozzle to cause  
25 the liquid to be drawn into ligamentary form and thereafter break up into electrostatically charged droplets;

said element being composed of a non-fibrous, non-felted, resiliently deformable material having open porosity and being in the form of a strip of said material having a profiled edge presenting at least one crest extending between opposite faces of the strip material whereby,  
30 in operation of the device, the liquid is fed by capillary action to said profiled edge and is discharged as two or more ligaments from said crest(s).

13. A device as claimed in any one of Claims 1 to 12 in which said material is composed of hydrophobic material.

35 14. A device as claimed in any one of Claims 1 to 13 in which said material is a polymeric material.

15. A device as claimed in any one of Claims 1 to 14 in which said material is composed of a material having a dielectric constant of at least 2.8 (measured at  $10^6$  Hz).

16. A device as claimed in any one of Claims 3, 4, 5, 8, 9, 10 and 11, or Claim 12, 13, 14 or 15 when appendant thereto, in which the thickness of the material is no greater than 2mm (preferably no greater than 1mm).

17. A device as claimed in any one of the preceding claims in which the reservoir comprises a container into which said element extends and which is of squat configuration with its shortest dimension parallel with the axis of elongation of said element.

18. A device as claimed in Claim 17 containing a liquid which is sprayable by the device and in which the element provides a capillary rise such that, when the device is disposed with said element directed vertically upwards, the spraying flow rate does not vary by more than 10% in response to the liquid level within the container ranging between the full and empty conditions of the container.

19. A device as claimed in Claim 12 or any one of Claims 13 to 18 as appendant to Claim 12 in which said material is a foam material.

20. A device as claimed in Claim 8, 9 or 12 or any one of Claims 13 to 18 when appendant thereto in which said strip is of elongated configuration and said profiled edge is provided at one end of the strip.

21. A personal care or hygiene spraying appliance comprising a device as claimed in any one of the preceding claims adapted for hand held use.

22. A fragrance dispensing appliance comprising a device as claimed in any one of Claims 1 to 20, the device being adapted for use location with the spraying nozzle thereof disposed to effect spraying in a predominantly vertically upwards direction.

23. A cartridge for use in an electrostatic spraying device comprising a container forming a reservoir for liquid to be sprayed and a nozzle or wick element having the characteristics claimed in any one of Claims 1 to 20.

24. A method of electrostatically spraying a liquid comprising: feeding the liquid from a reservoir thereof to an element of sheet material having open porosity and defining at least one spraying tip

or crest of chisel edge configuration whereby the liquid is drawn by capillary action to the tip(s) of the element; and applying high voltage to the liquid at said tip(s) or crest(s) so that the liquid is caused to issue in the form of ligaments at a plurality of sites along the chisel edge of the or each tip, which ligaments thereafter break up to form a spray of liquid droplets.

25. A method of producing a cartridge for use in an electrostatic spraying device comprising:

forming from a sheet of resiliently deformable non-fibrous, non-felted, hydrophobic material having open porosity a wick type element with a profiled spraying edge; and assembling said element to a container for liquid suitable for electrostatic spraying by inserting said element through an opening in the container so that said spraying edge projects from the container and a portion of the element extends into the interior of the container to provide a capillary feed path for liquid from the container to the profiled spraying edge.

26. A method as claimed in Claim 25 comprising furling said element about an axis of elongation thereof to enable it to be inserted through said opening.

27. A method as claimed in Claim 25 or 26 in which said element is formed by cutting through the thickness of the sheet whereby said profiled edge is constituted by a cut edge of the sheet.

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Fig. 1.

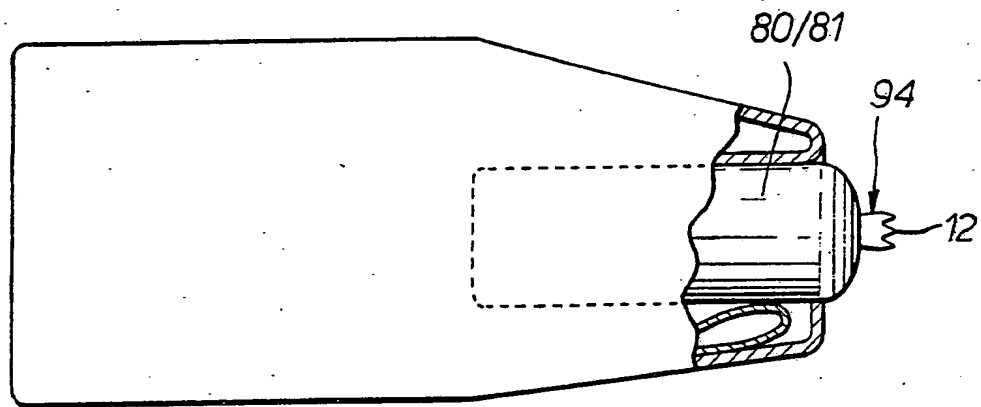
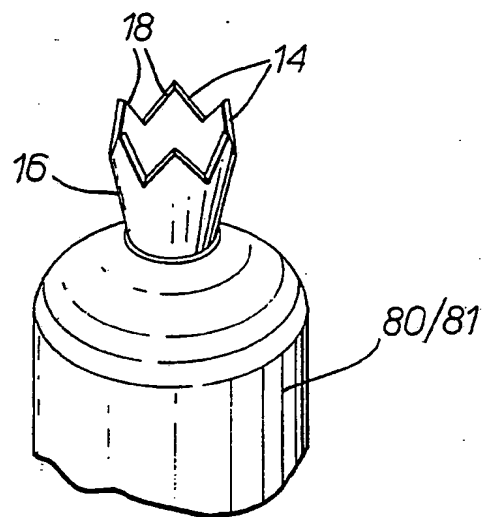


Fig. 2.



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Fig. 3.

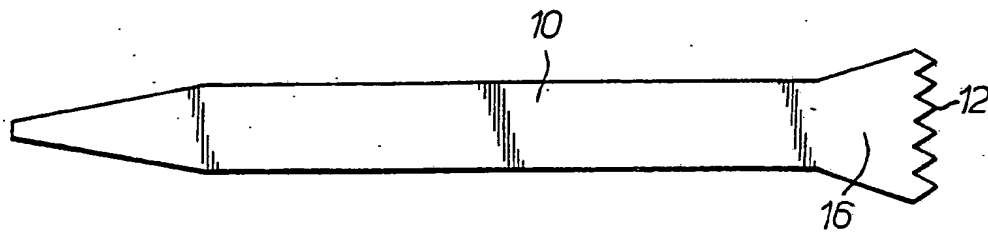


Fig. 4.

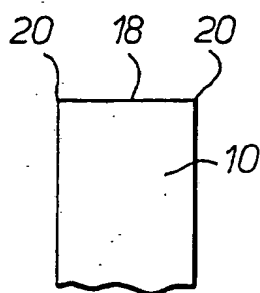


Fig. 5.

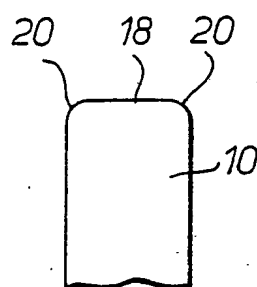
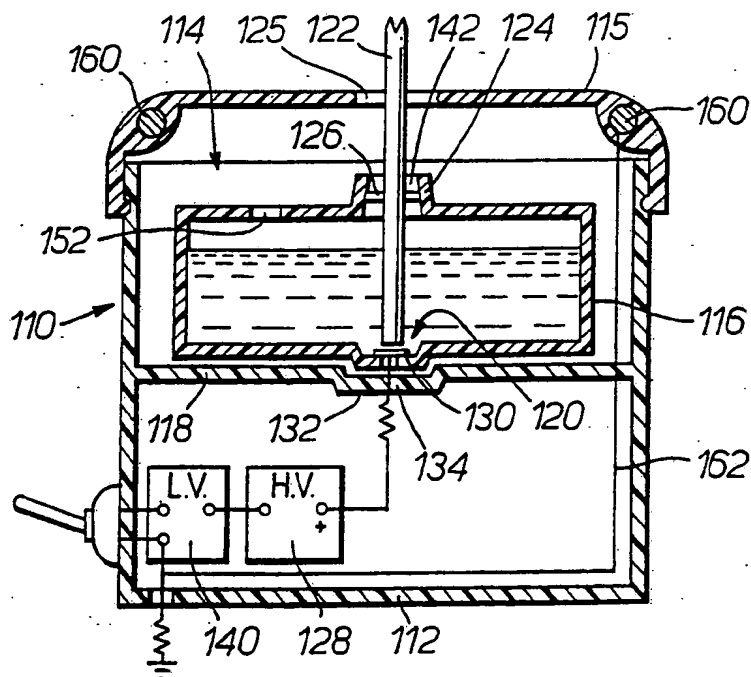


Fig. 6.



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 92/01712

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 B05B5/025; B05B5/16		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	B05B	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	EP,A,0 020 049 (THE SECRETARY OF STATE FOR INDUSTRY IN BRITAIN. GOVERNMENT OF UK OF GB) 10 December 1980 see claims; figures	1-12, 16, 17-20, 24-27
X	EP,A,0 120 633 (IMPERIAL CHEMICAL INDUSTRIES PLC) 3 October 1984 cited in the application see claims; figures	1
A	---	21-23
A	PATENT ABSTRACTS OF JAPAN (C-175)7 July 1985 & JP,A,58 067 375 ( HONDA GIKEN KOGYO KK ) 21 April 1983 see abstract	1, 11, 14, 19
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>10</sup> Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
28 JANUARY 1993	12 02 93	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	BREVIER F.J.	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A,P	EP,A,O 486 198 (IMPERIAL CHEMICAL INDUSTRIES PLC) 20 May 1992 see claims; figures -----	1-27

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

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SA 64662

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28/01/93

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		None	